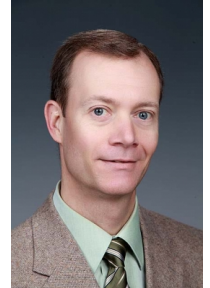


# LASSO\* – Science Requirements

*\*LES ARM Symbiotic Simulation and Observation (LASSO) workflow*



**Andy Vogelmann<sup>1</sup>, William I Gustafson Jr<sup>2</sup>  
Zhijin Li<sup>3,4</sup>, Xiaoping Cheng<sup>3</sup>,  
Satoshi Endo<sup>1</sup>, Tami Toto<sup>1</sup>, and Heng Xiao<sup>2</sup>**



<sup>1</sup>Brookhaven National Laboratory

<sup>2</sup>Pacific Northwest National Laboratory

<sup>3</sup>University of California Los Angeles

<sup>4</sup>NASA Jet Propulsion Laboratory

**And TONS of people from the rest of ARM!**

**LASSO Webpage:** <http://www.arm.gov/science/themes/lasso>

**LASSO e-mail list sign up:** <http://eepurl.com/bCS8s5>

# LASSO Overview

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## Goal of routine LES modeling at the ARM sites

- Add value to ARM observations by using LES modeling to provide context and a *self-consistent representation* of the atmosphere that connects processes and facilitates improved understanding.
- Produce a library of simulations to support the statistical study of atmospheric processes and support the improvement of the parameterizations of these processes in climate models. Also serve as a proxy for the atmosphere to develop remote sensing retrievals.

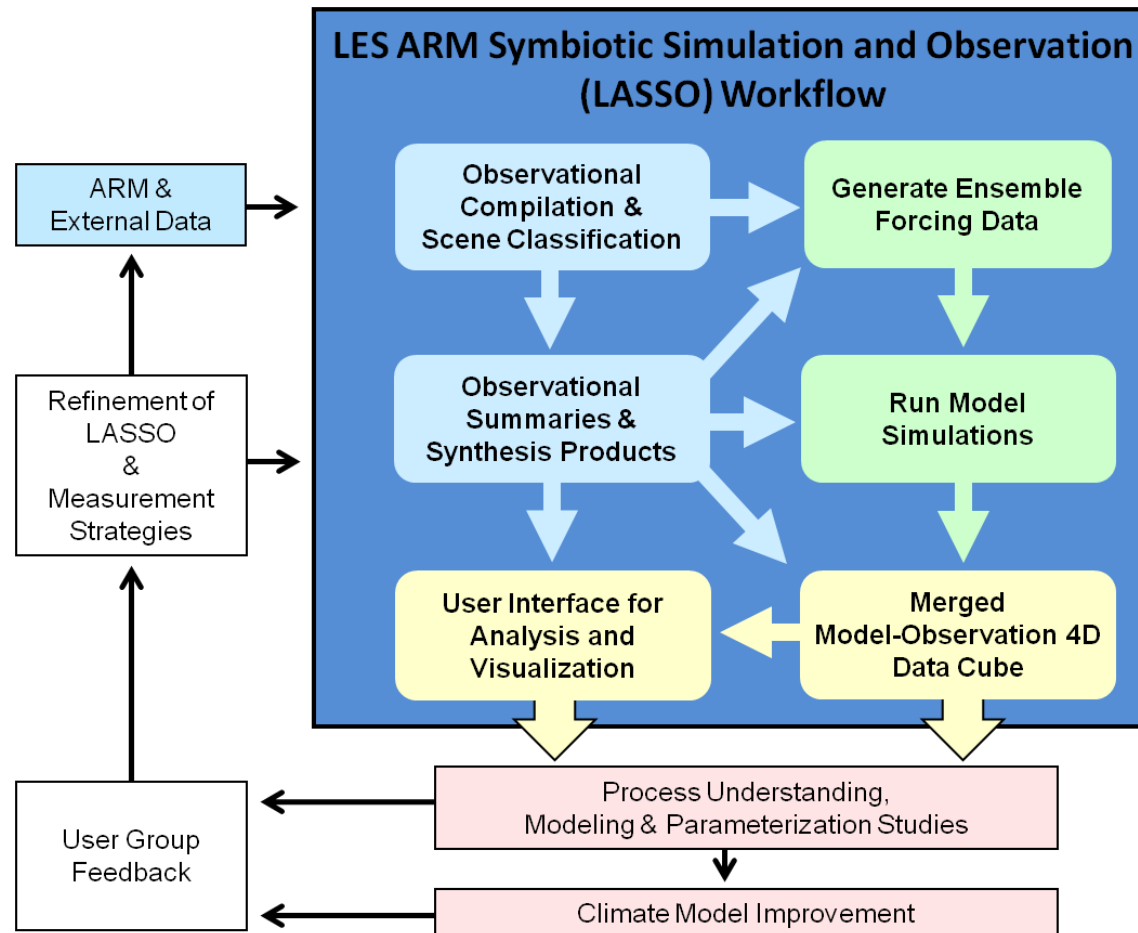
## The plan

- Starts at the Southern Great Plains megasite in 2017
- Initial implementation targets shallow clouds
- Later expands to other phenomena and ARM sites

## ARM observations integral to the effort

- Model initialization and forcings, including a data assimilation effort
- Evaluation of simulations
- Generation of model-observation “data cubes” for analysis by the community

# LASSO Workflow: 2-Year Pilot Phase

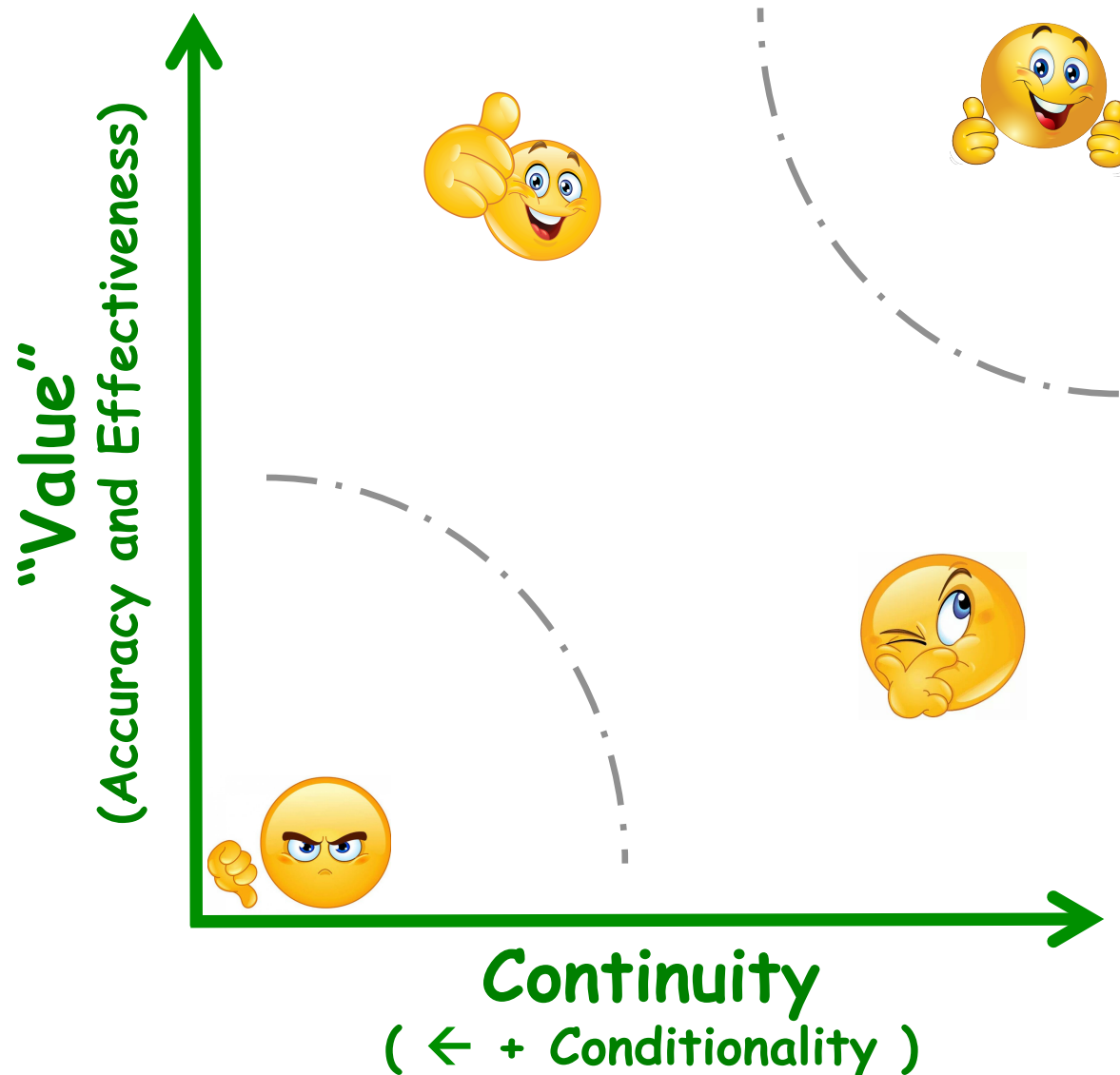


Major focus on getting something that works in place and improve it with time

- Implement things that already work
- Do not have time for experimenting with new/untested things

# LASSO Data Priorities

- Model forcing and initialization
- Model evaluation



# Prioritization of Radar-Related Observables

## Value

1 = Critical

2 = Important

3 = Nice to have

## Continuity

1 = Always

2 = Event conditionality

3 = “Irregular” conditionality

Keep in mind: large-eddy simulations are *statistical* in nature

- Biases are baaaaaaad
- RMS consistent with modeling framework, given adequate sampling



# Target Properties and Specifications (1)

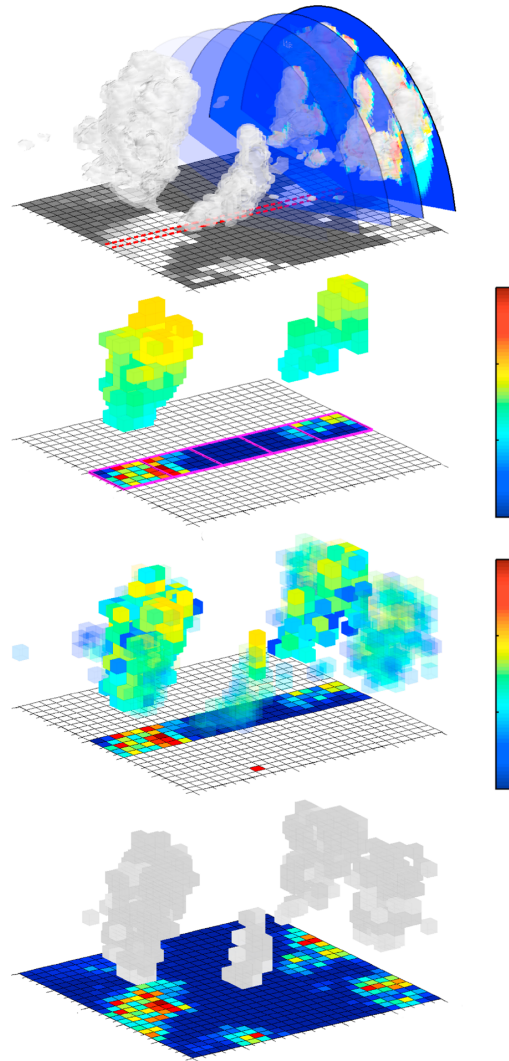
|                                                        | Value | Continuity | Desired Specifications                                                           | Comments                                                                                                    |
|--------------------------------------------------------|-------|------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Model Forcing &amp; Initialization</b>              |       |            |                                                                                  |                                                                                                             |
| Horizontal Winds                                       | 1     | 1          | Accuracy of 1 m/s and 3°<br>Vertical resolution:<br>30-40 m in BL<br>100 m above | Must be all-weather → RWP<br>~10-15 min averages<br>Also gets virtual temperature to 0.5 K                  |
| <b>In-Cloud Dynamics (instrument/method simulator)</b> |       |            |                                                                                  |                                                                                                             |
| Vertical velocity                                      | 1     | 2          | ≤ 20%                                                                            | Range-gate resolved                                                                                         |
| Mass flux                                              | 1     | 2          |                                                                                  |                                                                                                             |
| Turbulence                                             | 1-2   | 2-3        | ≤ 50%                                                                            | Turbulence and entrainment value not “1” (yet) because of potential issues matching with model computations |
| Entrainment                                            | 1-2   | 2-3        | ≤ 50%                                                                            |                                                                                                             |

# Target Properties and Specifications (2)

|                                                               | Value | Continuity | Desired Specifications                                                                                          | Comments                                                                                                                                                                   |
|---------------------------------------------------------------|-------|------------|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cloud Boundaries (radar simulator)</b>                     |       |            |                                                                                                                 |                                                                                                                                                                            |
| Cloud thickness/<br>Cloud-top height                          | 1-2   | 1-2        | $\leq 50\text{-}100\text{ m}$<br>(RACORO clouds $\sim 200\text{-}300\text{ m}$ thick)                           | Value reduced due to model resolution limitation<br>PDFs of 5-min “snapshots” aggregated over 15-20 min<br>Unknown effects of CTH radar detection and insect contamination |
| Cloud volume<br>boundaries (3-D)                              | 1-2   | 2          | $\leq 100\text{ m}$<br>(Limited by horizontal model resolution)                                                 | Value reduced due to model resolution limitation<br>Cloud-base area needed<br>PDF every 100 m in the vertical<br>Core-center height                                        |
| <b>Cloud Microphysics and Precipitation (radar simulator)</b> |       |            |                                                                                                                 |                                                                                                                                                                            |
| LWC                                                           | 1     | 2          | Whatever we can get (!), preferably $\sim 0.1\text{ gm}^{-3}$ (median for RACORO clouds)                        | Range-gate resolved                                                                                                                                                        |
| Drizzle                                                       | 2     | 2          | Projected area of occurrence $\sim 20\%$                                                                        | Value limited by drizzle frequency at SGP (vs. ENA)<br>Area more important than amount                                                                                     |
|                                                               | 2     | 3          | Drizzle rate at cloud base $\sim 100\%$                                                                         |                                                                                                                                                                            |
| Droplet number<br>concentration                               | 1     | 3          | MIN[50%, $< 250\text{ cm}^{-3}$ ], but anything would help (RACORO range was $100\text{-}1000\text{ cm}^{-3}$ ) | Conditional on LWC detection and probably other factors that would affect continuity                                                                                       |

# Synthesis Products

For example, ENCORE (ENsemble CLOud REtrieval method)





# Summary

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This is a work in progress

We are interested in your feedback!

[vogelmann@bnl.gov](mailto:vogelmann@bnl.gov)

[William.Gustafson@pnnl.gov](mailto:William.Gustafson@pnnl.gov)

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# Unused Slides

# Highlights of the Pilot Project's 2-Year Timeframe

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- |                     |                                                                                                                                                                                                      |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>May 2015</b>     | Funding started                                                                                                                                                                                      |
| <b>May 2016</b>     | ARM/ASR Joint Meeting May – Coming out party!                                                                                                                                                        |
| <b>June 2016</b>    | Availability of initial simulations for shallow convection cases during spring–summer 2015 (6–10 cases) with associated forcing, observational data.<br>→ Beta users (including ASR call, CMDV call) |
| <b>January 2017</b> | Simulations available for spring–summer 2016 that include input data from the <u>new boundary facilities</u> .                                                                                       |
| <b>May 2017</b>     | Pilot phase completed                                                                                                                                                                                |

# LASSO ARM Data Infusion

## Four main ARM data uses

### a. Scene classification

Cloud classification VAP (Sunny & Laura)

### b. Forcing generation & Initialization

Atmos state profiles (T, Q, horizontal winds)

SH & LH or soil moisture (Noah LS)

Other surface observations (Mesonet)

Variation of initial conditions

### c. Evaluation diagnostics & metrics

Cloud properties

Vertical velocities

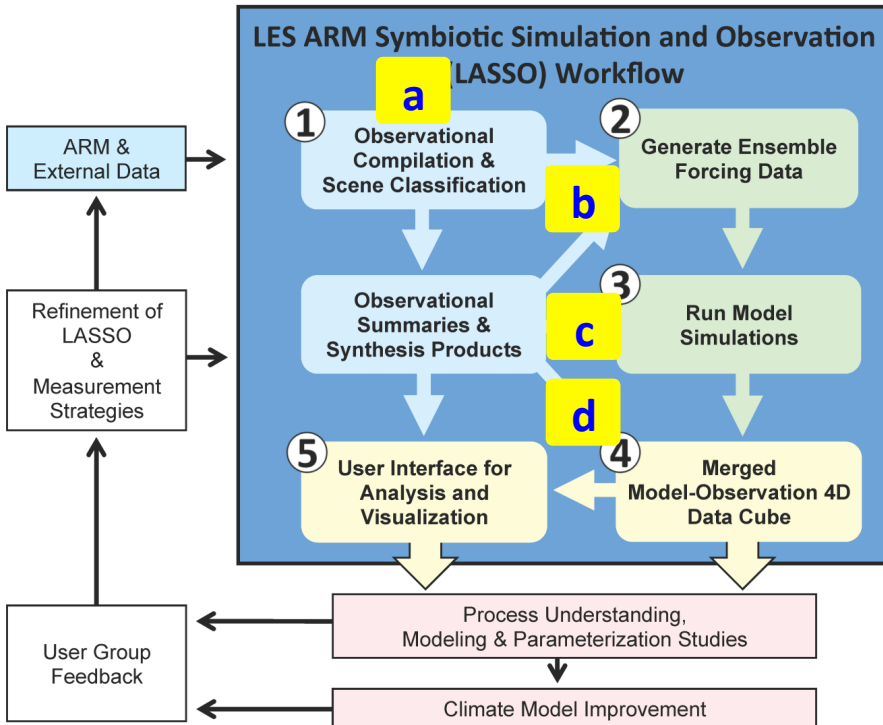
Other unassimilated variables

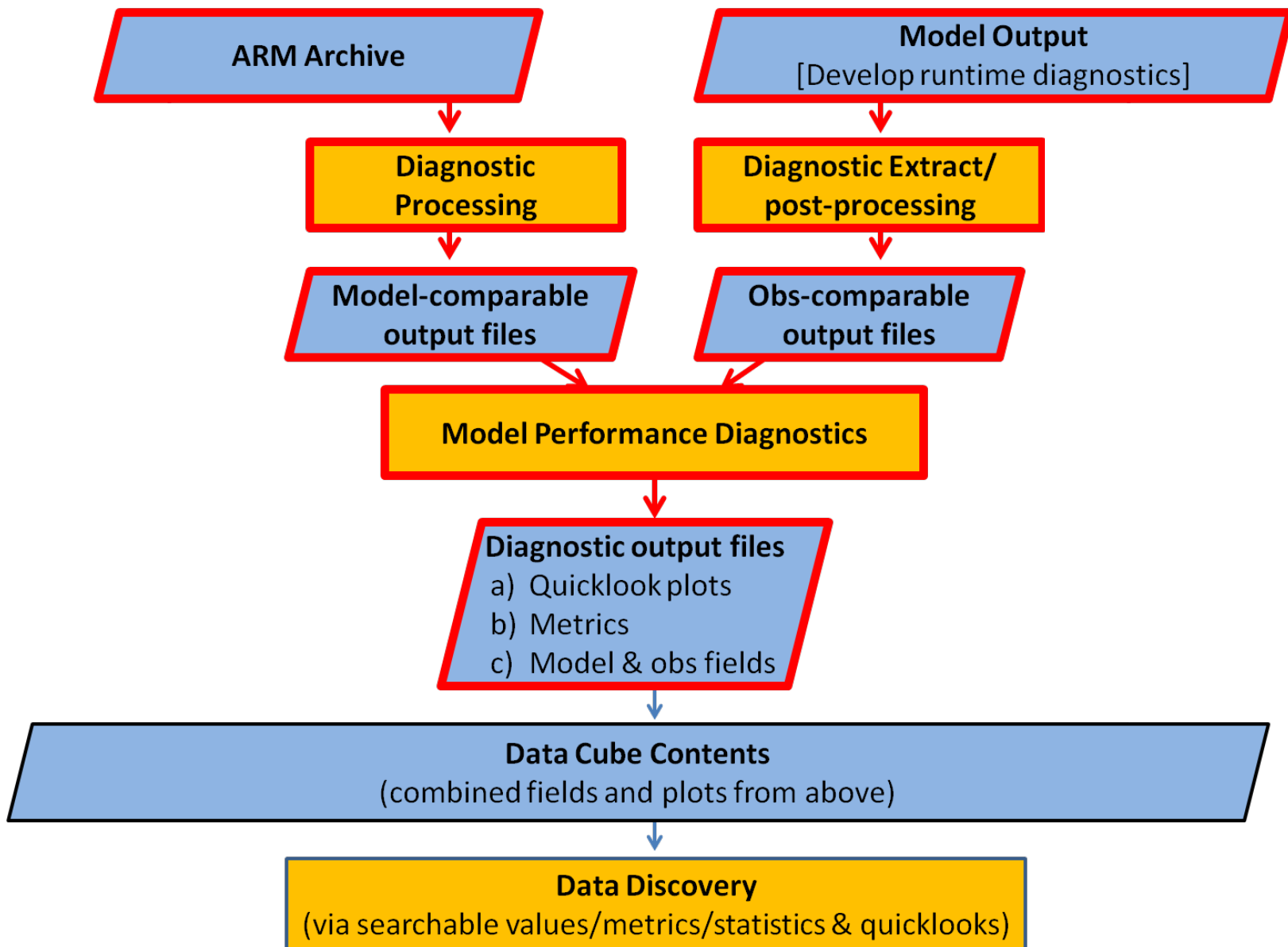
### d. Data cube generation

Observations

Observation-comparable model variables

Other non-comparable model fields





# Model Forcing Generation

MS-DA needs ARM atmospheric observations

- Profiles of T, Q, and horizontal winds

Wind profilers needed for boundary layer winds

- Mixture of precip mode with BL mode effective?

→ January 2017 deadline for delivery of initial simulations using new boundary facility data

